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Research Article

Impact of Preoperative Intravitreal Anti-VEGF on Vitrectomy for Proliferative Diabetic Retinopathy: A Prospective Study

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Abstract:
Proliferative diabetic retinopathy (PDR) remains a major cause of vision loss worldwide, primarily due to fibrovascular proliferation and vitreous hemorrhage requiring pars plana vitrectomy (PPV). The present prospective interventional study evaluates the impact of preoperative intravitreal anti-vascular endothelial growth factor (anti-VEGF) injection on intraoperative and postoperative outcomes in patients undergoing vitrectomy for PDR. The objective is to determine whether preoperative anti-VEGF reduces intraoperative bleeding, surgical time, and postoperative complications while improving visual outcomes.

A total of 80 eyes of 80 patients with advanced PDR were allocated into two groups: Group A received intravitreal anti-VEGF 3–5 days prior to PPV, while Group B underwent PPV without preoperative injection. Results demonstrated statistically significant reduction in intraoperative bleeding score ($p<0.001$), mean surgical duration ($p=0.002$), and postoperative vitreous hemorrhage rates ($p=0.01$) in Group A compared to Group B. Improvement in best-corrected visual acuity (BCVA) at 3 months was also significantly higher in the intervention group ($p=0.01$).

Preoperative anti-VEGF injection appears to facilitate safer and more efficient vitrectomy by inducing regression of neovascularization and reducing intraoperative complications. The findings suggest an important adjunctive role of anti-VEGF in surgical management of PDR. Further large-scale randomized studies are recommended to validate long-term benefits and optimize timing protocols.

Keywords: Proliferative Diabetic Retinopathy, Anti-VEGF, Vitrectomy

Introduction:

Proliferative diabetic retinopathy (PDR) represents the advanced stage of diabetic microvascular disease and continues to be one of the leading causes of preventable blindness in the working-age population globally. It is characterized by retinal ischemia-induced neovascularization, fibrovascular proliferation, and subsequent complications such as vitreous hemorrhage and tractional retinal detachment. Despite advancements in pharmacologic and surgical interventions, the management of PDR remains challenging due to the aggressive

nature of neovascular membranes and their intraoperative bleeding tendency during pars plana vitrectomy (PPV) [1–3].

In recent years, the role of vascular endothelial growth factor (VEGF) in mediating pathological angiogenesis has been well established. VEGF levels are significantly elevated in the vitreous of patients with PDR, correlating with disease severity and active neovascularization. The introduction of anti-VEGF agents has revolutionized the management of retinal vascular disorders by targeting the molecular pathway responsible for abnormal vessel growth. Intravitreal administration of anti-VEGF agents such as bevacizumab, ranibizumab, and aflibercept has demonstrated efficacy in reducing neovascular activity and vascular permeability [2–5].

The use of anti-VEGF as an adjunct before vitrectomy has gained increasing attention in recent surgical literature. The theoretical advantage lies in inducing regression of fragile neovascular tufts, thereby decreasing intraoperative bleeding, improving surgical field clarity, and reducing operative time. However, concerns have also been raised regarding potential induction of fibrotic contraction following VEGF suppression, which may exacerbate tractional retinal detachment if timing is not appropriately optimized [4–6].

Pars plana vitrectomy remains the gold standard surgical intervention for advanced PDR, particularly in cases complicated by non-clearing vitreous hemorrhage or tractional retinal detachment involving the macula. Surgical difficulty is often compounded by intraoperative bleeding from friable neovascular membranes, which increases the risk of iatrogenic retinal breaks and prolonged surgical duration. Hence, optimizing the preoperative environment has become an important focus in modern vitreoretinal surgery [3–6].

Recent clinical investigations have explored the timing and efficacy of preoperative anti-VEGF injections, with most studies suggesting a beneficial effect when administered within 3–7 days before surgery. This timing is believed to allow sufficient regression of neovascular tissue while minimizing fibrotic contraction risks. However, variability in patient response and surgical outcomes necessitates further prospective evaluation under controlled conditions [5–8].

With the global rise in diabetes prevalence, particularly in South Asian populations, the burden of PDR is expected to increase significantly over the coming decades. This emphasizes the need for optimized surgical strategies that not only improve anatomical outcomes but also enhance functional visual recovery and reduce perioperative complications. Current literature continues to evolve, with ongoing debates regarding standardized protocols for anti-VEGF timing, dosage, and agent selection [7–10].

In this context, the present prospective study was designed to evaluate the impact of preoperative intravitreal anti-VEGF injection on vitrectomy outcomes in patients with PDR. The study aims to assess intraoperative parameters such as bleeding intensity and surgical duration, as well as postoperative outcomes including vitreous hemorrhage recurrence and visual acuity improvement. By addressing these parameters, the study seeks to contribute to the optimization of surgical protocols in diabetic vitreoretinal management [8–10].

Methodology

A prospective interventional study was conducted at Al-Shifa Trust Eye Hospital, Rawalpindi, Pakistan involving 80 eyes of 80 patients diagnosed with proliferative diabetic retinopathy requiring pars plana vitrectomy due to non-clearing vitreous hemorrhage and/or tractional retinal detachment threatening or involving the macula. Patients

were recruited from a tertiary eye care center over a defined study period. The sample size was calculated using Epi Info software (Centers for Disease Control and Prevention, Atlanta, USA), considering a confidence level of 95%, power of 80%, and expected reduction in intraoperative bleeding complication rate of approximately 30% based on prior literature. The minimum calculated sample size was 72 eyes, which was increased to 80 to compensate for potential dropouts.

Participants were divided into two equal groups: Group A (n=40) received a single intravitreal injection of anti-VEGF (bevacizumab 1.25 mg/0.05 mL) 3–5 days prior to PPV, while Group B (n=40) underwent PPV without preoperative injection. All surgeries were performed using standardized 23-gauge pars plana vitrectomy systems by experienced vitreoretinal surgeons under similar operative settings to minimize bias.

Inclusion criteria comprised patients aged 30–70 years with type 1 or type 2 diabetes mellitus, diagnosed with PDR requiring surgical intervention due to vitreous hemorrhage or tractional retinal detachment. Exclusion criteria included prior vitreoretinal surgery, coexisting ocular diseases such as advanced glaucoma or age-related macular degeneration, history of intravitreal anti-VEGF within 3 months, and systemic contraindications to surgery or follow-up non-compliance.

Verbal informed consent was obtained from all participants after explaining the nature and possible risks of the procedure, and the study adhered to ethical principles consistent with the Declaration of Helsinki. Preoperative evaluation included best-corrected visual acuity (BCVA), slit lamp examination, fundus assessment, and B-scan ultrasonography when required. Intraoperative parameters recorded included surgical duration, intraoperative bleeding score (graded 0–3), need for endodiathermy, and intraoperative complications. Postoperative follow-up was conducted at 1 week, 1 month, and 3 months to assess BCVA improvement and incidence of recurrent vitreous hemorrhage.

Statistical analysis was performed using SPSS software version 25.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as percentages. Independent t-test was used for intergroup comparison, and chi-square test was applied for categorical variables. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Demographic and Baseline Characteristics

Parameter	Group A (Anti-VEGF)	Group B (Control)	p-value
Mean age (years)	55.2 ± 8.1	54.6 ± 7.9	0.72
Male (%)	60%	62.5%	0.81
Duration of diabetes (years)	12.4 ± 3.2	11.9 ± 3.5	0.58
HbA1c (%)	8.6 ± 1.2	8.4 ± 1.3	0.65
Baseline BCVA (LogMAR)	1.6 ± 0.3	1.5 ± 0.4	0.48

Brief explanation: No statistically significant difference was observed in baseline demographic or clinical parameters, confirming comparability of both groups.

Table 2: Intraoperative Outcomes

Parameter	Group A	Group B	p-value
Surgical time (min)	58.3 ± 9.4	72.6 ± 11.2	0.002
Bleeding score (0–3)	1.1 ± 0.5	2.4 ± 0.6	<0.001
Endodiathermy use (%)	25%	55%	0.01

Brief explanation: Preoperative anti-VEGF significantly reduced intraoperative bleeding severity, surgical duration, and need for adjunctive hemostasis.

Table 3: Postoperative Outcomes (3 months)

Parameter	Group A	Group B	p-value
BCVA improvement (LogMAR)	-0.7 ± 0.2	-0.4 ± 0.3	0.01
Recurrent VH (%)	10%	30%	0.01
Anatomical success (%)	95%	85%	0.04

Brief explanation: Functional and anatomical outcomes were significantly better in the anti-VEGF group with reduced recurrence of vitreous hemorrhage.

Discussion

The present prospective investigation demonstrates that preoperative intravitreal anti-VEGF administration significantly improves both intraoperative and postoperative outcomes in pars plana vitrectomy for proliferative diabetic retinopathy. The reduction in intraoperative bleeding score and surgical duration reflects a biologically plausible effect of VEGF suppression on neovascular regression and vascular stabilization. These findings are consistent with contemporary surgical paradigms emphasizing pharmacologic modulation of the vitreoretinal interface prior to intervention, which has been increasingly explored in recent clinical literature [11–12].

The marked reduction in intraoperative hemorrhage observed in the anti-VEGF group can be attributed to the rapid involution of fragile neovascular complexes. VEGF plays a central role in maintaining endothelial proliferation and vascular permeability; its inhibition leads to endothelial apoptosis and vessel regression. Consequently, fibrovascular membranes become less vascular and more amenable to dissection. Similar intraoperative benefits have been reported in recent studies where bevacizumab or aflibercept was administered preoperatively within a short window before surgery, reinforcing the temporal dependency of anti-VEGF efficacy [12–13].

A notable observation in this study is the statistically significant reduction in surgical time. This reduction is clinically relevant as prolonged vitreoretinal surgery is associated with increased risk of iatrogenic retinal breaks, lens injury, and postoperative inflammation. Improved visualization of the surgical field due to decreased bleeding likely contributed to more efficient membrane dissection and reduced need for endodiathermy. These findings align with emerging evidence suggesting that preoperative VEGF suppression enhances surgical ergonomics and procedural safety [13–14].

Postoperative outcomes further strengthen the role of preoperative anti-VEGF therapy. The significantly lower recurrence of vitreous hemorrhage in the intervention

group suggests improved hemostasis and reduced postoperative vascular reactivation. This may be explained by sustained VEGF suppression during the early postoperative healing phase, where neovascular proliferation is typically most active. Recent studies have similarly highlighted reduced rebleeding rates and improved anatomical stability when anti-VEGF is administered prior to vitrectomy [14–15].

Functional outcomes, as measured by improvement in best-corrected visual acuity, were also superior in the anti-VEGF group. This improvement is likely multifactorial, involving reduced intraoperative trauma, improved retinal reattachment conditions, and decreased postoperative inflammatory response. The correlation between reduced intraoperative bleeding and better visual recovery underscores the importance of surgical field optimization in retinal outcomes. Comparable findings in recent literature suggest that preoperative anti-VEGF therapy contributes to faster visual rehabilitation and improved patient satisfaction [15–16].

However, despite these benefits, concerns regarding potential fibrotic contraction remain clinically relevant. VEGF inhibition may theoretically accelerate fibrotic activity by altering the balance between angiogenic and fibrotic cytokines, potentially worsening tractional retinal detachment in select cases if administered too early. In this study, no increased incidence of intraoperative tractional complications was observed, likely due to careful timing of injection within the 3–5 day preoperative window. This timing appears critical in balancing neovascular regression with fibrotic stability, as supported by recent surgical outcome analyses [16–17].

Another important aspect is patient selection. The uniform baseline characteristics between groups ensured that observed differences were attributable to the intervention rather than confounding systemic or ocular variables. Diabetes duration, glycemic control, and baseline visual acuity were comparable, strengthening the internal validity of the findings. Current evidence emphasizes that systemic metabolic control remains a major determinant of surgical outcomes, but adjunctive pharmacologic modulation significantly enhances procedural success rates [17–18].

From a broader clinical perspective, the findings of this study reinforce the evolving paradigm of combined pharmacologic and surgical management in proliferative diabetic retinopathy. Anti-VEGF therapy is no longer limited to primary retinal disease control but has become an essential adjunct in optimizing surgical conditions. This integrated approach reflects a shift toward precision vitreoretinal surgery, where preoperative biological modulation is used to enhance surgical efficiency and safety. Recent multicenter studies have similarly advocated for standardized preoperative anti-VEGF protocols in complex diabetic vitreoretinal cases [18–20].

Overall, the present study contributes to the growing body of evidence supporting preoperative anti-VEGF use as a valuable adjunct in vitrectomy for PDR. The statistically significant improvements in intraoperative and postoperative parameters underscore its clinical relevance. However, variability in response, optimal timing, and long-term outcomes still require further multicenter randomized controlled trials to establish standardized guidelines for universal application [19–20].

Conclusion

Preoperative intravitreal anti-VEGF significantly enhances surgical outcomes in proliferative diabetic retinopathy by reducing intraoperative bleeding, shortening surgical time, and improving postoperative visual recovery.

The intervention demonstrates a clear

advantage in both functional and anatomical success without increasing complication rates when appropriately timed. Further large-scale studies are required to standardize protocols and refine patient selection for optimal long-term outcomes.

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